

## SOME RECENT TREASURES OF THE SNOW

By WILSON A. BENTLEY

[Jericho, Vt., May 22, 1927]

The past winter, 1926-27, noted for its mildness and scant snowfall in Vermont, goes on record as a fairly favorable winter for snow-crystal photography. There were 12 favorable snowfalls, and although 10 of them were light, and furnished only about a dozen photographs each, two of them—the storms of January 23 and February 22—furnished large sets of crystals (over 40 each). December furnished three favorable storms, the 4th, 6th, and 20th; January, six, the 1st, 2d, 5th, 15th, 17th, and 23d; and February, three, the 3d, 9th, and 22d. Of these, four were cold snowfalls, occurring during temperatures ranging from 5° above to 5° F. below zero.

The winter furnished about 200 new photomicrographs, among them more than the usual number of exceptional or "wonderful" crystals; 40 of them can be classed as such.

The new snow gems were doubly welcome because of the fact that recent winters, since 1920, have been rather unfavorable. The recent winters seemed to have gotten into a habit of periodicity as regards the character of their snowfall.

The winters 1912 to 1915, inclusive, were unfavorable. Those, 1916-1920, were very favorable; then followed a long period, 1921-1926, of unfavorable ones, broken only by the last winter. Looking further back over my record, I find no well-established periods. The winters 1902, 1904, 1907, 1910, and 1911 were favorable ones. Those of 1905, 1906, and 1909 were among the least favorable ones. Although the recent unfavorable period, 1921-1926, furnished a total of only 673 new snow crystal photomicrographs, an average of but 112 per winter, each winter furnished nevertheless its quota of about 7 each, of exceptional or masterpiece crystals, so that the six years' collection, as a whole, with the new ones added the last winter, is a wonderful and priceless addition to my numerous collection, now over 4,700 snow crystals.

Among the recent ones photographed during the seven year period are a few (20) that were taken in Canada at the invitation of Dr. H. T. Barnes, of McGill University.

I spent most of the winter of 1925 at Morrisburg on the St. Lawrence River, about 80 miles upriver from Montreal, carrying on my snow-crystal work there. I had wished for years to try photographic work a little farther north in Canada, because I thought it might be even more favorable for my work there than at Jericho, Vt.

The winter of 1925, however, happened to be an unfavorable one, so I was left somewhat in doubt as to whether the Canadian location was favorable or not, yet from the data secured I feel sure that the modifying influence of the Great Lakes to the westward is an unfavorable influence. The lakes tend to raise the temperature of the air both at the surface and presumably in cloudland, and thus favor the production of granular snow and granular-covered crystals; so I returned home with the query in my mind, "Could it be that through some strange freak of accident or providence, that the one man who loves the snowflakes most had been born at the one most favorable spot on earth for the study and photographing of them?"

My Canadian location, however, proved very favorable for the study and photography of hoar frost effects, both on outdoor objects and upon window panes. The water vapor evaporated from the great St. Lawrence, crystallized in forms of wonderful beauty and magnifi-

cence, particularly upon the window panes at Morrisburg and elsewhere along the great river.

Resuming once more in 1926 my work at my home location, I have succeeded in photographing many new and wonderful snow crystals the past two winters.

A brief chronological review and mention of some of the results of my more recent work during the seven-year period 1921-1927 may be of interest. Among the most wonderful crystals of this period is one (3950) that fell November 26 in the early winter of 1922. I have named it the "good luck," or horseshoe crystal. It not only has a horseshoe pictured as its nuclear feature, but more wonderful still, it has six surrounding features, each of which resembles a horse's hoof with heel calks.

The beautiful branching one that fell December 9, 1921, No. 3999, is also a masterpiece of crystal architecture.

The winter of 1923 produced among others three very exquisite specimens. One of these (No. 4149), which fell during the very cold snowfall of December 7, 1922, is a very marvellous quasi-trigonal crystal. The thrillingly beautiful one (No. 4215) of January 10, 1920, is also very notable, and also No. 4273 because of the beautiful circular arrangement of its tiny loops and scallops.

The winter of 1924 produced among others No. 4273, just mentioned, and No. 4308.

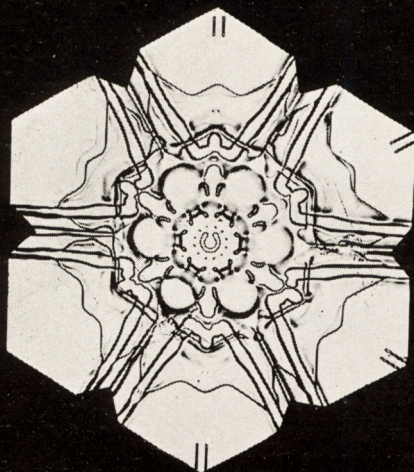
Passing over the many charming ones of the 1925 crop we come to some notable ones of 1926. The snows of the early winter of 1926 were rich in perfect snow gems. One rarely lovely one of this series is shown in No. 4538. Two of those of this winter are of surpassing interest. Both fell during the cold and heavy snowfall of February 4, 1926. This storm was rich in triangular forms and furnished many having outlines similar to the wonderful No. 4404. It also produced the marvellous No. 4408.

As previously noted, the winter of 1927 was quite favorable. The writer wishes all the readers of the REVIEW could see and enjoy the snowflake masterpieces of this winter.

The storm of January 1 furnished among others the lovely plate-form crystal (No. 4572), and also a wonderful dotted one (No. 4562). But the storm of January 17 made itself even more famous by producing one of the oddest snow crystals ever photographed (No. 4621), named the "clock crystal" because it so much resembles the face of a clock.

Soon afterward came the storm of January 23, which made itself noted by furnishing the largest set of snow crystals yet photographed during a single storm—53. Many of these fell during the night but so thick and substantial were they that masses of them were taken indoors on a shingle into a cold room where the still air caused less evaporation and were used all day for photographic purposes. Among those of this set were some that were truly "wonder" crystals. No. 4640 has dark, shadowy features arranged around its nuclear star, forming a unique design of rare beauty. Many of the tabular plates possessed beautifully arranged systems of tiny dots and dashes as a nuclear feature. Often these were surrounded by bold, well-marked features in a similar manner to those shown in No. 4656.

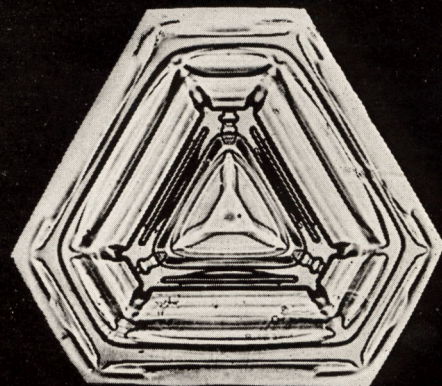
The 1927 snowflake season had an early but wonderfully brilliant closing on February 22. On that date, in the early morning, the clouds for a while showered the earth with starry, fernlike gems such as thrill, amaze, and delight snowflake lovers. Many of these crystals



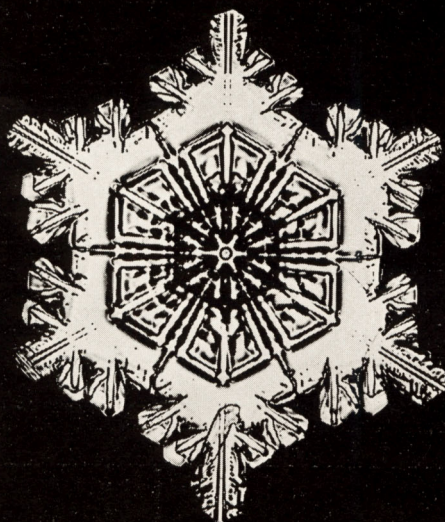
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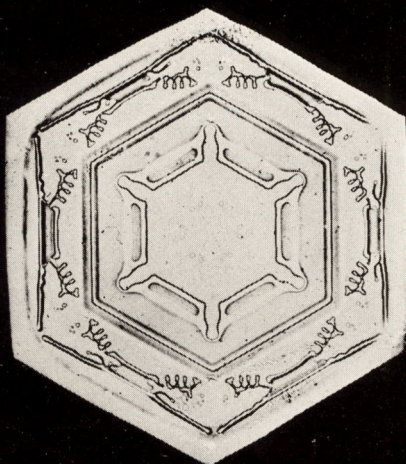
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4149



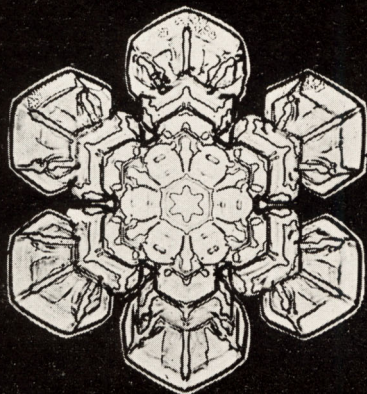
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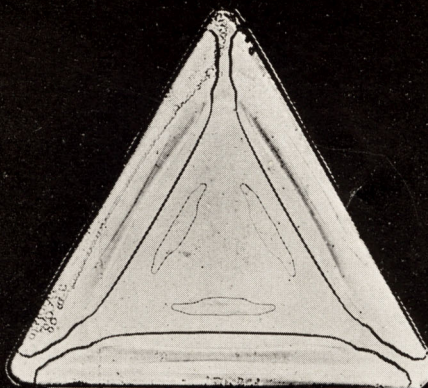
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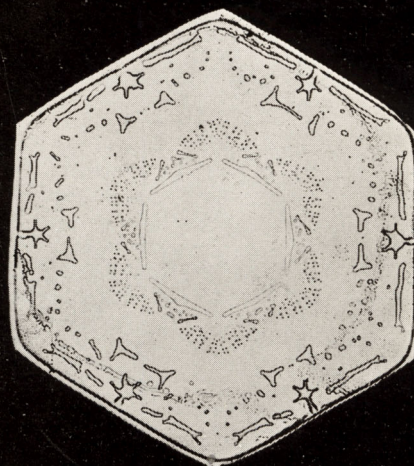
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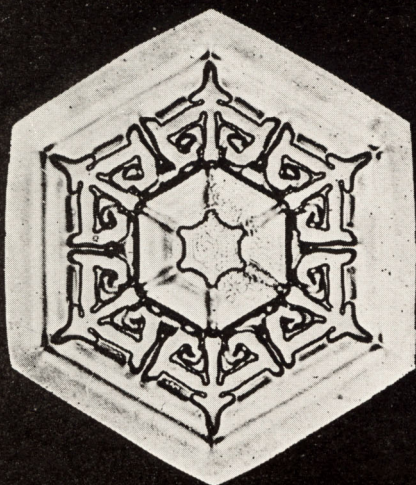
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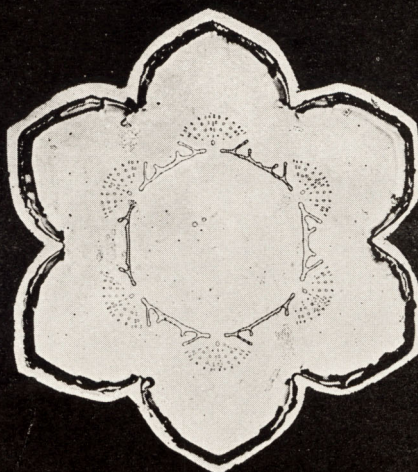
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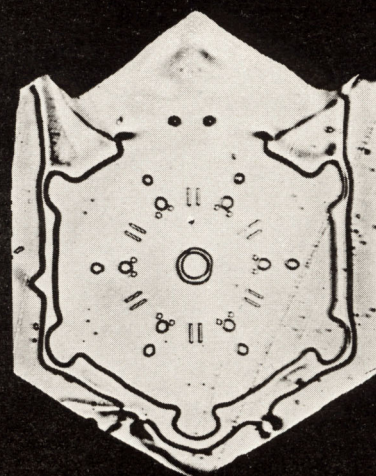
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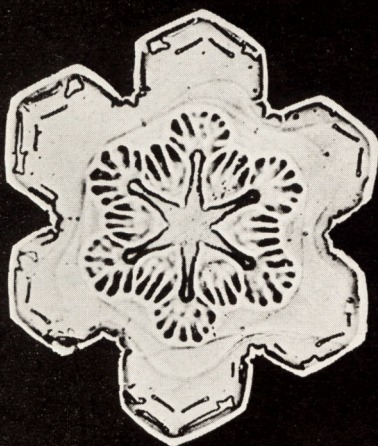
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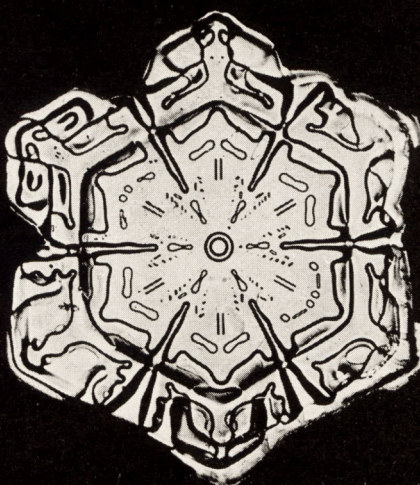
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4621



4640



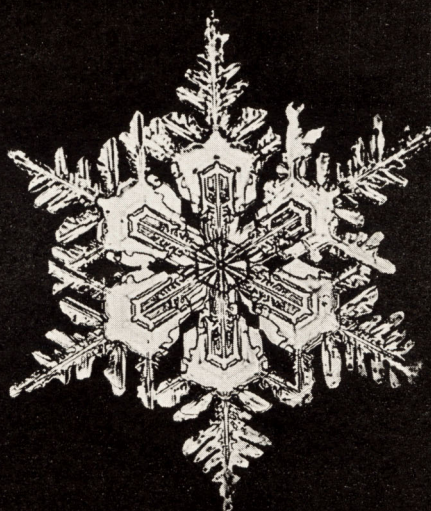
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4711



4695



4716



4726

were of extraordinary size, some being one-half inch in diameter. So heavy were they that many of them were broken in alighting upon my blackboard.

The snowflakes in this storm were so substantial that after the snow ceased I took quantities of them indoors and used them for photographing until nearly noon, when sunlight and rising temperature prevented further work. Although many of the crystals were somewhat deformed by unequal evaporation, the set as a whole is of exquisite beauty—a priceless addition to my series of branching crystals. It will be noted that the general effect of the arrangement of the multitudes of secondary and tertiary degree rays around the axial rays is beautifully symmetrical. Yet a closer analysis discloses that no two of the axial and pendant rays are alike, and that the secondary and tertiary degree rays are not always arranged opposite each other in pairs as is often the case. This suggests colloidal crystallization, the use by the growing crystals, in part, of groups of water molecules not completely subject to crystallographic law.

A thorough analysis of this wonderful series of branching crystals leaves one in doubt as to which ones are the most beautiful and interesting. The drooping pattern of No. 4711 recalls some of the drawings of Glaisher. The downward growth of rays of the third degree in No. 4695 forms a lovely, unique pattern. Very interesting also are the branchy rays arranged as peripheral adornments around the solid centerpiece of No. 4716.

#### C. E. P. BROOKS<sup>1</sup> ON THE EFFECT OF FLUCTUATIONS OF THE GULF STREAM ON THE DISTRIBUTION OF PRESSURE

By A. J. HENRY

It has been recognized for many years that in one way or another the Gulf Stream affects the weather of western Europe but in just what way is not so definitely known.

Doctor Brooks seeks the answer by means of a very comprehensive statistical comparison between fluctuations in the strength of the Gulf Stream and the subsequent weather.

Data as to the volume and temperature of the Gulf Stream not being available the author goes back a step to the causes which must produce variations in the volume and temperature of the water of the stream, viz, to variations in the NE. and SE. trades of the Atlantic Ocean. These as is well known give rise to the Gulf Stream. Since in its travel of several thousand miles there is the possibility that its temperature may be influenced by one or more variables along its course it was necessary to investigate the subject under the following heads:

1. NE. trades.
2. SE. trades.
3. Pressure at Habana.
4. Pressure difference Bermuda—Charleston.
5. Pressure difference Bermuda—Sydney.
6. Pressure difference Azores—Iceland.
7. Pressure difference Stornoway—Iceland.

At the outset the author investigates the rate of flow of the various branches of the Atlantic circulation and presents the results shown in Table 1 below. The rates and speeds shown are of course only the roughest approximations, yet they serve to give an idea of the time required for variations in the currents in one part of the Atlantic to be propagated along the course of the currents to other parts of the ocean.

<sup>1</sup> Air Ministry, Meteorological Office, Geophysical Memoirs No. 34, by C. E. P. Brooks, D. Sc.

Perhaps most interesting of all is No. 4726, because it shows so beautifully the tendency, so often seen in some form, by many hexagonal crystals, to divide into three. In this specimen it will be noted that the main secondary rays of each alternate axial ray have grown farther than those lying between them, thus forming a triangular effect.

This brief account of the newer "treasures of the snow" will perhaps once more serve to inspire renewed interest in the peerless snow gems and to emphasize the fact that the treasures of the snow are absolutely inexhaustible, almost untouched as yet.

The writer is happy in the thought of having added during recent years so many new snow gems of the "first water" to his already numerous collection of over 4,700 specimens, of which no two are alike. There is much room also for gratification in the fact that there is an ever increasing interest in snow crystals the world over, as proven by the manner in which they are being featured by the press, magazines, lecturers, museums, textbooks, and moving pictures, as well as the new uses of them as designs in the arts, crafts, and industrial sciences.

As the writer looks back 44 years to the beginning of his seemingly unimportant study of snow crystals, it seems to him remarkable that the work should have produced such undreamed of results. Perhaps it is not too much to say that the results of his studies form one of the "little romances of science."

TABLE 1.—Speeds and times of North Atlantic circulation

Current	From—	To—	Distance (nautical miles)	Speed, (miles per day)	Mean time in days
North Equatorial.....	16° N., 25° W.	16° N., 60° W.	1,900	17	112
Antilles.....	16° N., 60° W.	23° N., 75° W.	850	12	71
South Equatorial.....	St. Helena.....	5° N., 40° W.	2,800	20	140
Guiana Current.....	5° N., 40° W.	20° N., 80° W.	2,400	35	69
Yucatan to Florida Strait.....	Round.....	Gulf of Mexico.	(500)	(20)	(25)
Gulf Stream:					
Florida Strait to Cape Hatteras.....	23° N., 80° W.	36° N., 75° W.	600	70	9
Cape Hatteras to New- foundland.....	36° N., 75° W.	42° N., 50° W.	1,200	38	32
Newfoundland to Azores.....	42° N., 50° W.	40° N., 26° W.	1,200	10	120
Newfoundland to north of Scotland.....	42° N., 50° W.	60° N., 5° W.	1,800	12	150

The initial assumption is that the effect of the various factors, trade winds, pressure differences, etc., are caused mainly through temperature variations carried along by the Gulf Stream and the Gulf Stream drift.

Correlation coefficients were first computed between the velocity of the NE. trade and subsequent pressure over western Europe, the final objective being, of course, the discovery of a relation that might be useful in long-range weather forecasting.

The following-named stations were used to represent the pressure over western Europe: Jacobshavn (west coast of Greenland); Stykkisholm, Iceland; Thorshavn, Faroes; Ponta Delgada, Azores; Valencia; Paris; Berlin; Bergen and Vardo, Norway.

The pressures at these stations were correlated with the trade wind velocities for the same quarter, for the preceding quarter, and so on over a period of two years. In addition to the regular quarterly coefficients representing intervals of 3, 6, 9, . . . months pressures were also correlated with the velocities of the trade wind four months earlier—i. e., pressure January to March with velocity